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Mechanism of ozone destruction based on observation of atmospheric minor species derived with FTIR at Syowa Station

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Atmospheric observation using Fourier transform infrared spectrometer (FTIR) was conducted by the 48th Japanese Antarctic Research Expedition (JARE-48) in 2007, at Syowa Station. Because FTIR enables us to observe several minor species at the same time, we can get chemical variation regardless of dynamical variation by comparing minor species with trace gas species. Our purpose is to quantify the ozone depletion amount by the comparison with its related species, and to understand the mechanism of ozone depletion with using FTIR observational data by JARE-48.

We use Bruker's IFS-120M FTIR for measurements, and SFIT2 program developed by NIWA, NCAR and Univ. of Wollongong for spectral analysis to deduce column amounts and VMR profiles. There were 87 observational days, from February 2007 to January 2008. In these days, there were several ozone sonde observations and Polar Stratospheric Cloud (PSC) observations by low resolution FTIR. In this study, we analyzed six kinds of atmospheric minor species, O_3, HNO_3, N_2O, HF, HCl and $ClONO_2$.

Regarding to O_3observational results, daily column amounts well agreed with Dobson spectrophotometer observations and daily VMR profiles almost agreed with ozone sonde observations. As for HNO_3, N_2O, HF, HCl and $ClONO_2$, we could confirm the agreement of the FTIR observation with the satellite observational data.

In July 29, 30 and August 1, 2007, PSCs appeared over Syowa Station. We evaluated the chemical variation of ozone depletion from O_3-N_2O correlation curve and we found that ozone depletion amount in Aug. 1 was larger than other two days. We calculated back trajectories of these three days from 17km above Syowa, which was considered to be the largest ozone depletion altitude. As a result, it was suggested that air parcels experienced below T_{NAT}temperature (195K) before arrived at Syowa in these three days. Especially, on Aug. 1, air parcel experienced below T_{ICE}temperature (188K) and PSCs were produced at lower temperature. Because of the above reason, ozone depletion on Aug. 1 was the largest than other two days. Depletion of nitric acid was also large on Aug. 1, which was evaluated by HNO_3-N_2O correlation curve. This fact suggests that ozone depletion at the surface of ice PSC particles was large.

Also, FTIR observation data indicated the inactivating process of chlorine as follows: From winter to spring, nitric chemical species were eliminated by denitrification, and this prevented increase of $ClONO_2$concentration, which is one of the chlorine reservoir. After that, significant ozone depletion by active chlorine led increase of Cl/ClO ratio. Finally, HCl ,which is also one of the chlorine reservoir, were reproduced.

Keywords: ozone destruction, stratosphere, PSCs, Antarctica, FTIR, denitrification